Docket No. AUS920000406US1

EDITING PLATFORMS FOR REMOTE USER INTERFACE TRANSLATION

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates generally to tools for internationalization of software. More particularly, the present invention relates to an improved method, apparatus, and computer program for performing language translation in computer software.

2. Description of Related Art:

Java is an object-oriented, compiled, multi-threaded computer language that generates platform-independent executable files.

Java is object-oriented. This means, in the simplest terms, that it allows for the association of member functions or "methods" within data structures. Indeed, all Java programs are made up solely of data structure types known as "classes," where classes contain both data fields and methods.

Classes may "inherit" characteristics of other classes. When a "descendant" class inherits from another "ancestral" class, it inherits all of the data fields and methods of the ancestral class. In addition, a descendent class may provide its own methods to supplement or take the place of ancestral class methods.

Java is compiled. That means that before a Java program (written as source code) can be executed, it must be processed by a compiler to make an executable form of the program. Executable Java programs are stored in ".class" files, with each ".class" file containing

executable object code for a single Java class.

Java is multi-threaded. This means that a single Java program can have several sequences of code executing concurrently. Each of these sequences is known as a thread. Multi-threaded program languages, such as Java, are very useful when writing software such as, for instance, communication software, where it is helpful to allow the software to perform other tasks while waiting for input.

Java produces platform-independent executables. When a Java program is compiled to produce ".class" files, those ".class" files are capable of being executed on any platform having a Java runtime environment. A Java runtime environment is a piece of software that allows a computer to executes Java ".class" files. Java runtime environments are available for many, if not most, commonly used computer platforms today.

There are essentially two kinds of Java runtime environments: interpreters and just-in-time compilers. Interpreters directly interpret the binary code contained in ".class" files and execute instructions corresponding to that binary code as the interpretation process is carried out. Just-in-time compilers, on the other hand, first translate the binary code into native instructions, then execute the native instructions. Native instructions are instructions that are designed to be executed directly by the computer's hardware.

Java's "write once, run anywhere" philosophy extends not only into the realm of platform independence, but also to that of software internationalization, where a principle of "write once, run anywhere in the world" applies. Java was among the first computer language

standards to embrace Unicode, a sixteen-bit character set standard that includes not only the twenty-six letters of modern English, but a variety of characters and accented characters used in other languages. The sixteen-bit standard allows a sufficient range of characters (65,536) not only for the inclusion of multiple alphabets, such as Cyrillic and Hebrew, but also for the character sets of languages such as Chinese and Japanese. Chinese does not use an alphabet but relies on the use of thousands of different ideograms; Japanese uses two alphabets in addition to a set of approximately two thousand ideograms.

Java also provides a facility for internationalization known as "Resource Bundles." Resource bundles are files that store the text messages displayed by a Java program. When a Java program uses resource bundles, it loads its text messages from the resource bundle to be displayed to a user.

By separating text messages from the program code that displays them, it becomes easier to generate versions of a program that display in different languages. To make a German translation of an English original to a program, for instance, one need only create a German resource bundle to be interchanged with the English one. Thus, keeping to Java's "write once, run anywhere" philosophy, the Java program code need only be written and compiled once.

The task of translating a piece of software from one language to another, then, consists of translating the text contained in a resource bundle to produce a replacement resource bundle containing the translation text. Although this scheme is simple from a theoretical

and technological standpoint, in practice the task of translating software is more complicated.

It is generally impractical for a software-producing organization to employ a staff of translators for every language at every location in the organization where software is produced. A more practical approach, and one that is generally taken within the industry, is assign the responsibility for software translation to one or more translators in remote locations (often in other countries). In theory, a simple approach to software translation would be to send the resource bundles associated with a product to the translator, have the translator make new resource bundles containing translated text, then have the translator return the new resource bundles.

This approach is error prone, however. The translator, having only the text of the program to look at, is at a loss as to the context in which the text is used. When a translator is given no context in which to understand the text, the translator must make a guess as to which meaning is intended and choose a translation that matches the meaning. For instance, the English word "stop" may be translated into German as "halten," "anhalten," "aufhalten," "aufhören," "abstellen," "einstellen," or "stehenbleiben," depending on the context. The best a translator can do, having only the word "stop" to translate into German, is to pick a likely candidate, for instance "halten." Then, at some later time, the translator can view the completed translated software title to check the context.

Because translators are not usually technically trained or familiar with the technical details of the

software they are translating, however, viewing the completed title may be unduly difficult for the translator. Many software products today, particularly those intended to be operated over a network, are difficult to set up and operate, particularly for one with little technical background. It is often impractical for a translator working in a remote location from the software developers to have a working copy of the software installed at the translator's location. When this is the case, often the only viable option is to have the translator travel to the software developers' location and "proofread" the translated software under the direction of the developers.

Another problem that a translator may experience is that the translator may not know enough about operating the software to be able to observe all of the necessary textual messages within the context of the program. In such cases, the developers' assistance is also needed to ensure that all messages are displayed in context for translation.

What is needed then, is a method of translating the text of a software product that reduces the necessity of the translator working face-to-face with software developers.

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SUMMARY OF THE INVENTION

The present invention provides techniques for translating the text displayed by a computer program into another language for international use of the program. These techniques simplify the translation process and reduce the necessity for active software developer or programmer involvement with the translation process.

In one embodiment of the invention, data regarding the context in which text is presented to a user is collected from an executing program. This data and the text itself can be forwarded to a translator, who then uses a context interpreter to recreate the presentation of the text in context, without resorting to the use of the original program. The translator can then edit the resource bundle while having its contents displayed in context on the screen Thus, an accurate translation may be made by a translator without the translator's having a copy of the program installed.

In another embodiment of the invention, a sequence of system events corresponding to user actions during an execution session of a program is recorded. This sequence can be forwarded, along with an executable of the program, to a translator. The translator can then use a scripting shell to "playback" the execution session of the program. During "playback," the translator may pause the execution of the program and make editorial changes to text on screen using what is known as an "introspective editor." Thus, a translator may make a translation of a software product without having to know how to operate the software product and without having a software developer or programmer present to demonstrate

the software product.

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BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a block diagram of a data processing system in the present invention may be implemented;

Figure 2A is a diagram depicting the relationships of a graphical user interface, a resource bundle, and program code in accordance with an embodiment of the present invention;

Figure 2B is a diagram demonstrating how a translation of software may be made by interchanging resource bundles in accordance with an embodiment of the present invention;

Figure 3 is a diagram depicting the general operation of an embodiment of the present invention;

Figure 4 is a listing of a Java class for a GUI feature written in accordance with an embodiment of the present invention;

Figure 5 is a diagram depicting the process of reproducing GUI features for editing from context modules and resource bundles in accordance with an embodiment of the present invention;

Figure 6 is a screen shot of an GUI window being edited using an introspective editor in accordance with an embodiment of the present invention;

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Figure 7 is a diagram depicting the general operation of an alternative embodiment of the present invention;

Figure 8 is a diagram depicting the operation of a scripting shell in conjunction with an introspective editor in accordance with an embodiment of the present invention;

Figure 9A is a flowchart representation of a process for storing contextual data (context modules) in accordance with an embodiment of the present invention;

Figure 9B is a flowchart representation of a process for rendering and editing program text using contextual and textual data in accordance with an embodiment of the present invention;

Figure 10A is a flowchart representation of a process for recording a sequence of system events in accordance with an embodiment of the present invention; and

Figure 10B is a flowchart representation of a process for reproducing a sequence of system events to affect the execution of a program containing an introspective editor in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference now to the figures, and in particular with reference to **Figure 1**, a block diagram of a data processing system **100** in which the present invention may be implemented is illustrated. Data processing system **100** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Micro Channel and ISA may be used. Processor **102** and main memory **104** are connected to PCI local bus **106** through PCI bridge **108**. PCI bridge **108** also may include an integrated memory controller and cache memory for processor **102**. Additional connections to PCI local bus **106** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **110**, SCSI host bus adapter **112**, and expansion bus interface **114** are connected to PCI local bus **106** by direct component connection. In contrast, audio adapter **116**, graphics adapter **118**, and audio/video adapter (A/V) **119** are connected to PCI local bus **106** by add-in boards inserted into expansion slots. Expansion bus interface **114** provides a connection for a keyboard and mouse adapter **120**, modem **122**, and additional memory **124**. SCSI host bus adapter **112** provides a connection for hard disk drive **126**, tape drive **128**, CD-ROM **130**, and digital video disc read only memory drive (DVD-ROM) **132** in the depicted example. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors. Those of ordinary skill in the art will appreciate that the hardware in **Figure 1** may vary. For example, other

peripheral devices, such as optical disk drives and the like may be used in addition to or in place of the hardware depicted in **Figure 1**. The depicted example is not meant to imply architectural limitations with respect to the present invention.

Figure 2A is a diagram depicting how language-specific information is separated from an executable program using Java resource bundles in accordance with an embodiment of the present invention. Window **200A** is displayed to a user as part of a graphical user interface when executable program code **201A** is executed. Window **200A** contains several textual and graphical features, including window title **202A,** label **204A**, and buttons **206A** and **208A**. The text contained in these features is stored in resource bundle **210A** separately from program code **201A**. When program code **201A** displays window **200A**, it loads the text for features **202A**, **204A**, **206A**, and **208A** from resource bundle **210A**.

As **Figure 2A** illustrates, separating executable program code **201A** from resource bundle **210A** makes it easy to produce new versions of the program to run in different languages. While window **200A** in **Figure 2A** was in English, window **200B** in **Figure 2B** is in German. Features **202B**, **204B**, **206B, and 208B**, while rendered similarly to features **202A**, **204A**, **206A**, and **208A** of **Figure 2A,** have (roughly) equivalent German text substituted for the English. The German text is stored in resource bundle **210B**, which is loaded by executable program code **201A**, the identical program code as in **Figure 2A**. Resource bundle **210B** is thus both separate from program code **201A** and interchangeable with other

resource bundles produced to be used by program code **201A**. Translation of a piece of software from one language to another merely requires that a translator prepare a new resource bundle for the new language.

Resource bundle **210B**, however, only contains the German text. It does not contain any information about how the text is used within the program, its context. **Figure 3** shows how system **300** of the present invention collects contextual information from an executing program to allow translation of a software product without the translator having access to the executable program.

Program **302** executes in a Java runtime environment on a computer system or other data processing system, such as data processing system **100** in **Figure 1**. Monitor process **304** monitors the execution of program **302** to detect when program **302** generates graphical user interface (GUI) features, such as windows, dialog boxes, or menus. Monitor process **304** may execute as a separate executable process from program **302** or as a thread within program **302**. Alternatively, monitor process **304** need not be within its own thread or process of execution, but might be implemented as simply a set of functions called by program **302** whenever a GUI feature is generated.

Each time program **302** generates a GUI feature, monitor process **304** generates a context module containing instructions for rendering the GUI feature. This context module is added to a collection of context modules **306**. Context modules **306** are then combined with program **302**'s resource bundles **308** as input to a context interpreter **310**, which may be executed on a separate computer and at any time after context modules **306** are generated.

Context interpreter **310** uses context modules **306** and resource bundles **308** to reproduce the GUI features originally generated by program **302**. The reproduced GUI features are then displayed to a translator on a display device **312**.

Context interpreter **310** contains an introspective editor. The introspective editor is a library, that when compiled into an executable program, allows a user to edit GUI features while the program is executing.

When a program compiled with an introspective editor is executing and the user wishes to change the text displayed by the program, the user issues a special keystroke while simultaneously clicking the GUI feature to edit with the mouse. This action brings up a dialog box such as dialog box **604** in **Figure 6**, for editing the textual information associated with that feature. The introspective editor is described in commonly assigned, copending application 09/362,615, which is incorporated herein by reference.

The translator can thus provide input **314** to context interpreter **310** to translate the text of the displayed GUI features. Once the translator has finished translating the GUI features, context interpreter **310** produces new resource bundles **316** containing the translation text.

Figure 4 is a diagram of a Java listing in accordance with one embodiment of the present invention. Those of ordinary skill in the art will appreciate that such a software implementation is not limited to the use of the Java language but may be implemented in any of a variety of computer languages, including but not limited to C, C++, Forth, Lisp, Scheme, Python, Perl, and

Assembly Languages of all kinds. It is also to be emphasized that this Java listing is merely an example of one possible implementation of the present invention, included to clarify the basic concepts underlying the invention by providing them in a concrete form. **Figure 4** should not be interpreted as limiting the invention to a particular software implementation

Figure 4 depicts one way in which the generation of GUI features can be detected by a monitor process. Java class "GUIFeature2" **400** is a descendent class of ancestral Java class "GUIFeature" (not listed), which generates a GUI feature. In an actual implementation, any GUI feature-generating class, such as "java.awt.Window" could be used as an ancestral class. Class "GUIFeature2" **400** is written to provide the same functionality as "GUIFeature" while collecting contextual data for creating context modules.

Constructor function **402** is called when an instance of class "GUIFeature2" **400** is created. Constructor function **402** takes arguments **403** as input. Arguments **403** are the same arguments that would be passed into the constructor function of ancestral class "GUIFeature." Arguments **403** contain the contextual information necessary to render the GUI feature represented by class "GUIFeature."

Line **404** contains a call to function "Monitor.log_GUIFeature2," which takes arguments **403**. Function "Monitor.log_GUIFeature2" creates a context module corresponding to the GUI feature being created by constructor function **402** and inserts the contextual data in arguments **403** into the context module. Finally, on line **406**, the constructor function of the ancestral class

"GUIFeature" is called using the Java keyword "super." Thus, by creating an instance of class "GUIFeature2" **400**, the GUI feature of class "GUIFeature" is generated and the contextual data necessary to generate the GUI feature is stored in a context module.

Figure 5 is a diagram depicting the rendering of GUI features from context modules and resource modules using context interpreter **310**. Context interpreter **310** combines graphical rendering information from context bundle **502** and combines that information with text from resource bundle **504**. Context interpreter **500** then uses the combined information to render GUI feature **506**, which in this case is a window.

Figure 6 is a screen shot of an introspective editor, written in accordance with an embodiment of the present invention. Window **600** contains a button **602**, which a user is editing with the introspective editor. The user selects button **602** with a mouse or keyboard, and editing dialog box **604** is displayed.

Dialog box **604** contains fields for editing resource bundle-related information associated with button **602**. These fields include the new (replacement) text **606**, the particular resource bundle used **608**, the resource key **610** for button **602** (which is an internal identification for the GUI feature being edited), and the previous text **612**. After editing the fields of dialog box **604** to produce a translation of button **602**, the user may use the mouse or keyboard to actuate button **614** to save the translation or button **616** to discard the translation.

Figure 7 depicts an alternative embodiment of the present invention based on the idea of storing system

events to reproduce a sequence of GUI features for translation. Program **700** executes in a Java runtime environment on a computer system or other data processing system. Journal process **702** monitors the execution of program **700** or of the underlying operating system or runtime environment to detect when program **700** processes system events. System events include mouse clicks, keystrokes, and other input/output events.

Journal process **702** may execute as a separate executable process from program **700** or as a thread within program **700**. In such cases, journal process **702** will generally monitor a system queue (associated with the operating system of the computer) to detect system events. Alternatively, journal process **702** need not be within its own thread or process of execution, but might be implemented as simply a set of functions called by program **700** whenever a system event is handled by program **700**. GUI-based programs generally include an event handler function for receiving system events. System events may be in an event sequence whenever the event handler function executes.

Each time program **700** handles a system event, journal process **702** logs the system event in an event sequence **704**. Event sequence **704**, then, becomes a transcript of a user's actions during an execution session of program **700**.

Event sequence **704** can then be fed as input into a scripting shell **706**. Scripting shell **706** executes an executable **708** of program **700** containing an introspective editor, as described in **Figure 6**. Thus, whereas in the embodiment described in **Figure 3**, the introspective

editor was incorporated into context interpreter **310**, in the embodiment in **Figure 7**, the introspective editor is incorporated into executable **708**, a complete executable versions of program **700**.

Scripting shell **706** reproduces the same system events (keystrokes, mouse clicks, etc.) that were performed when program **700** was originally executed and event sequence **704** was generated. Scripting shells that reproduce a sequence of system events are well known in the art and are often used to test and debug software. Thus, when scripting shell **706** generates system events while executing executable **708**, scripting shell **706** makes executable **708** perform the same tasks and display the same GUI features that program **700** did when originally executed.

Output from executable **708** is displayed on a display device **710**. While executable **608** is executing, a user may use an input device **712** such as a mouse or keyboard to direct scripting shell **706** to halt or continue sending system events to executable **708**. While scripting shell **706** is halted, the user may use the introspective editor to edit the text in resource bundles **714** associated with program **700**, to produce new resource bundles **716** containing the new text.

Figure 8 is a diagram depicting the operation of an alternative embodiment of the present invention in accordance with **Figure 7**. Sequence **800** is a sequence of screen shots from an execution of executable **708** (in **Figure 7**) using event sequence **704**. Event sequence **704** is a list of system events that occurred during an initial execution of program **702** (in **Figure 7**).

Screen **804** shows what the user's screen looks like when program **702** or executable **708** is first executed. After scripting shell **706** (from **Figure 7**) makes event **806** from event sequence **704** occur, screen **808** replaces screen **804** on the user's display. In this case, event **806** is a click of the mouse at a particular point. At any time the user may halt scripting shell **706** from generating system events and edit any of the GUI features on screen **808** using the introspective editor before resuming scripting shell **706**.

Similarly, after scripting shell **706** generates event **810**, the next event in event sequence **704**, screen **808** is replaced with screen **812**. This process can continue until scripting shell **706** generates the last event in event sequence **704**.

Figure 9A is a flowchart representation of the operation of a monitor process, such as monitor process **304** in **Figure 3,** in an embodiment of the present invention implemented in accordance with the diagram in **Figure 3**. If a GUI feature is to be generated (step **902**), then data regarding how the feature is to be rendered is stored in a context bundle (step **904**). Finally, the GUI feature is generated and displayed for the user (step **906**) and the process cycles back to step **902**.

Figure 9B is a flowchart representation of the operation of context-interpreter, such as context interpreter **310**, in an embodiment of the present invention implemented in accordance with the diagram in **Figure 3**. First, the program reads rendering data from a context bundle and textual data from, for instance, a

Java resource bundle (step **908**). Next, the rendering data and textual data are combined and the GUI feature is rendered complete with its associated text (step **910**). Next, the user may edit the text of the GUI feature (step **912**). Finally, the new text is saved (in a new resource bundle) (step **914**), with the process terminating thereafter.

Figure 10A is a flowchart representation of the operation of a journal process, such as journal process **702** in **Figure 7**, and executing program, such as executing program **700** in **Figure 7**, in an embodiment of the present invention implemented in accordance with the diagram in **Figure 7**. If a system event has occurred (step **1000**), the journal process records the event in an event sequence (step **1002**). Next, the system event is handled by the executing program (step **1004**) and the process cycles back to step **1000**.

Figure 10B is a flowchart representation of a scripting shell, such as scripting shell **706** in **Figure 7**, in an embodiment of the present invention implemented in accordance with the diagram in **Figure 7**. First, the scripting shell starts the execution of an introspective editor-containing executable file of the program to be translated (step **1006**). Then a system event record is retrieved from an event sequence (step **1008**). Next, the system event represented by the record is generated so as to affect the execution of the executable (step **1010**). The process then recycles back to step **1006** to read and generate the next system event in the event sequence.

One of ordinary skill in the art will appreciate that although the embodiments described herein make use

of the Java programming language and the resource bundle facility in that language, the techniques described herein are applicable to a variety of other programming environments as well. For instance, it is a common practice to use "catalog files" to store text, regardless of the programming language used. Catalog files are files that, like resource bundles, store a series of text messages to be displayed by a program and are interchangeable with other catalog files in different (human) languages.

One of ordinary skill in the art will also appreciate that in some computing environments, such as Microsoft Windows for example, it is common practice to store GUI rendering information (and text as well) in separate files from program source code. These files are called "resource files." In an alternative embodiment of the present invention, resource files may be used in place of context modules, resource bundles, or both, for editing purposes.

Further, one of ordinary skill in the art will recognize that such text to be viewed in context and translated need not be confined to text displayed within a graphical user interface (GUI). Rather, the text translated using the present invention could include text displayed in a non-graphical environment, or text to be printed or otherwise conveyed to a user. Regardless of whether the text is displayed as part of a GUI, contextual data, such as how the text is arranged on a screen or printed on a page is still present and can still be recorded and used within an embodiment of the present invention.

Moreover, the present invention need not be limited to the translation of text. The present invention is applicable to the editing of computer program text in general. An editor, for instance, could use an embodiment of the present invention to correct grammar and punctuation mistakes in a program's text, rather than make a translation.

It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms, such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in

order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

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